PATENT ABSTRACTS OF JAPAN

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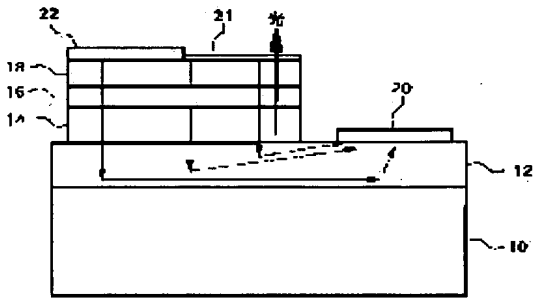
(54) GALLIUM NITRIDE COMPOUND SEMICONDUCTOR DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To improve a light fetching efficiency in a gallium nitride light emitting element.
SOLUTION: The gallium nitride light emitting element comprises an n-type GaN buffer layer 12, an n-type GaN layer 14, an InGaN light emitting layer 16, a p-type GaN layer 18, an n-type electrode 20, and a p-type electrode 22 sequentially formed on a sapphire substrate 10. A ZnO transparent electrode 21 is formed adjacent to the electrode 22 on the p-type GaN layer. A current is uniformly supplied to the light emitting layer via the electrode 21, and a light from the light emitting layer is transmitted and fetched externally.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] Gallium nitride system compound semiconductor equipment which is gallium nitride system compound semiconductor equipment, and is characterized by having a ZnO transparent electrode as an electrode.
[Claim 2] An n mold GaN system layer by which said gallium nitride system compound semiconductor equipment was formed on a substrate and a substrate, A GaN system luminous layer formed on said n mold GaN layer, and a p mold GaN system layer formed on said luminous layer, It has n mold electrode formed on an n mold GaN layer, and p mold electrode formed on said p mold GaN layer. Said ZnO transparent electrode It is gallium nitride system compound semiconductor equipment according to claim 1 characterized by being on said p mold GaN system layer, adjoining said p mold electrode, being formed, and for light from said luminous layer penetrating said ZnO transparent electrode, and injecting outside.
[Claim 3] Said ZnO transparent electrode is gallium nitride system compound semiconductor equipment given in either of claims 1 and 2 characterized by being p mold.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to improvement in gallium nitride system compound semiconductor equipment, especially luminous efficiency.
[0002]
[Description of the Prior Art] Before, the light emitting device using a gallium nitride (GaN) system compound semiconductor is known, and the application to blue LED etc. is considered.
[0003] The configuration of the light emitting device which used the GaN system compound semiconductor is shown in drawing 3 . The n mold GaN layer 12 is formed on silicon on sapphire 10, and the thin n mold GaN layer 14 is formed on the GaN layer 12. And the InGaN luminous layer 16 is formed as a luminous layer, the p mold GaN layer 18 is formed further, and a PN junction is constituted. After forming the p mold GaN layer 18, surface [a part of] is etched, the surface of the n mold GaN buffer layer 12 is exposed, and n mold electrode 20 is formed on the n mold GaN buffer layer 12, and p mold electrode 22 is formed in the surface of the p mold GaN layer 18. And by impressing forward voltage to p mold electrode 22 and n mold electrode 20, a carrier is poured into the InGaN luminous layer 16, and the light (blue) of predetermined wavelength injects from the InGaN luminous layer 16.
[0004]
[Problem(s) to be Solved by the Invention] However, with the configuration of drawing 3 , since current flows towards n mold electrode 20 and current flows most mostly in the lower part of p mold electrode 22 especially from p mold electrode 22, in the lower part of p mold electrode 22, luminescence becomes the strongest. However, the light injected from the InGaN luminous layer 16 will be interrupted by p mold electrode 22, and cannot take out efficiently the light which emitted light outside.
[0005] Then, conventionally, while forming metaled p mold electrode 22 on the p mold GaN layer 18, forming a transparent electrode is proposed. By forming a transparent electrode, current cannot be passed only in the lower part of p mold electrode 22, but luminous efficiency can be raised by the thing of the InGaN luminous layer 16 light is mostly taken [a thing] out from a sink and a transparent electrode for current to homogeneity over the whole surface.
[0006] However, in the former, nickel/Au or ITO (Indium Tin Oxide) is used as a transparent electrode, since nickel/Au is a metal, if its thickness of an electrode is thick, although current breadth becomes good, the permeability of light will worsen, and when the thickness of an electrode is thin, although often penetrated, since membranous longitudinal direction resistance becomes high, light has the problem of being hard to produce current breadth. Moreover, in ITO, although the permeability of light is high on the wavelength of 400nm or more, it has the conduction property of n mold, and since resistivity is not small, either, it has the problem to which current cannot flow with not sufficient ohmic contact in the p mold GaN layer 18 easily to homogeneity as a metal. Furthermore, ITO is comparatively difficult to etch, and when the configuration of the edge of the etched pattern tends to collapse, therefore it processes it as an electrode, it also has the problem from which a desired configuration is not acquired.
[0007] This invention is made in view of the technical problem which the above-mentioned conventional technology has, and the purpose is in offering the structure which can raise the luminous efficiency in the light emitting device which used the GaN system semiconductor.
[0008]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, this invention is gallium nitride system compound semiconductor equipment, and is characterized by having a ZnO transparent electrode as an electrode. ZnO becomes transparent above predetermined wavelength (350nm), and it can be taken out outside, without interrupting light. Moreover, resistivity is also low compared with a metal membrane, and since it excels in ohmic contact in a GaN system layer, current can be passed to homogeneity.
[0009] Here said gallium nitride system compound semiconductor equipment A substrate, an n mold GaN system layer formed on a substrate, and a GaN system luminous layer formed on said n mold GaN layer, It has a p mold GaN system layer formed on said luminous layer, n mold electrode formed on an n mold GaN layer, and p mold electrode formed on said p mold GaN layer. Said ZnO transparent electrode It is on said p mold GaN system layer, and said p mold electrode is adjoined, it is formed, and it is suitable for light from said luminous layer to penetrate said ZnO transparent electrode and to inject outside.
[0010] Moreover, considering as p mold is suitable for said ZnO transparent electrode. By considering as p mold, electric contact at the time of forming on a p mold GaN system layer can be made good.
[0011]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained based on a drawing.
[0012] The configuration of the GaN system semiconductor device concerning this operation gestalt is shown in drawing 1 . Although it is the same as that of the configuration shown in drawing 3 almost, while p mold electrode 22 is formed on the p mold GaN layer 18 unlike drawing 3 , p mold electrode is adjoined, the transparent electrode 21 is formed, and p mold electrode 22 and the transparent electrode 21 are unified as an electrode. This transparent electrode 21 is formed by ZnO.
[0013] The manufacture flow chart of the semiconductor device shown in drawing 1 is shown in drawing 2 . first, a silicon-on-sapphire 10 top — MOCVD — an n mold GaN buffer layer is formed by law etc. (S101). Forming at low temperature comparatively is suitable for a GaN buffer layer, and it is also suitable to precede to form a GaN buffer layer, to form SiN first, and to form the GaN buffer layer 12 on the SiN. Next, the n mold GaN layers 12 and 14 are formed on a GaN buffer layer by the MOCVD method (S102). It is also suitable for the n mold GaN layers 12 and 14 to dope silicon etc. like the formation fault. The n

mold GaN layer 12 can form 3 micrometers and about 0.1 micrometers of n mold GaN layers 14. MOCVD after forming the n mold GaN layers 12 and 14 — law -- the n mold InGaN luminous layer 16 — for example, about 2nm is formed (S103). the luminous layer 16 top after forming a luminous layer -- MOCVD -- the p mold GaN layer 18 is formed by law (S104). About 0.1 micrometers of p mold GaN layers can be formed, for example. After forming the p mold GaN layer 18, a part of the surface is etched by Mr. about 0.2-micrometer Fukashi, and the surface of the n mold GaN buffer layer 12 is exposed (S105). And aluminum electrode is formed by vacuum evaporationo, sputtering, etc. as an n mold electrode on the exposed n mold GaN buffer layer 12 (S106). Moreover, the Pt/Au electrode 22 is formed by vacuum evaporationo or sputtering on the p mold GaN layer 18 (S107).
[0014] After forming p mold electrode 22 and n mold electrode 20 as mentioned above, the p mold ZnO transparent electrode 21 is further formed using the sputtering method etc. on the p mold GaN layer 18 so that p mold electrode 22 may be touched (S108). It is known that ZnO will become transparence on the wavelength of 350nm or more, and an about [10-3ohmcm] film can be formed by the sputtering method (KTominaga, et al, Thin Solid Films243(1994) 9-13). and ZnO and GaN — a lattice constant (ZnO:a= — 3.252A) c= 5.213A, GaN:a=3.189A, c= 5.185A, ITO: Since both 10.13A and a coefficient of thermal expansion (ZnO:a shaft-orientations 2.9x10-6K-1, C shaft-orientations 4.75x10-6K-1, GaN:a shaft-orientations 5.59x10-6K-1, C shaft orientations 3.17x10-6 K-1) approximate, It excels in adhesion with the p mold GaN layer 18, and excels also in the etching property further. Furthermore, it is also known that the film of the p mold ZnO can be created (Jpn.J.Appl.Phys.Vol.38(1999) L1205-L1207 Part2, No.11A.1 November1999), and electric contact in the p mold GaN layer 18 can also be made good.
[0015] Thus, a transparent electrode is not formed by nickel/Au or ITO, but it is ZnO and forming a transparent electrode 21 especially with the p mold ZnO, electric adjustment with the p mold GaN layer 18 is raised, and uniform current is acquired, and an electrode configuration is also made with a desired configuration, and it becomes possible to take out light outside efficiently.
[0016] The applicant for this patent was able to acquire the following values, as a result of forming a light emitting device, using nickel/Au, ITO, the n mold ZnO, and the p mold ZnO as a material of a transparent electrode 21 and measuring the radiant power output.
[0017]
[A table 1]

透明電極材料	厚さ（ミクロン）	相対出力パワー（20mA）
Ni／Au	0.02/0.02	1
ITO	0.2	0.8-1.2
n－ZnO	0.2	1.5-1.8
p－ZnO	0.2	1.8-2.0

[0018] Here, all luminescence wavelength is 450nm. As shown in this table, compared with the conventional transparent electrode material (nickel/Au or ITO), relative output power is excellent, about about 2-time relative output power is obtained [especially / the former] in the p mold ZnO, and both the n mold ZnO and the p mold ZnO can take out light outside efficiently.
[0019] In addition, in this operation gestalt, although InGaN is used as a luminous layer, if it is a GaN system compound semiconductor, the material of arbitration can be used.
[0020]
[Effect of the Invention] Since ZnO was used for the transparent electrode according to this invention as explained above, it becomes possible to take out efficiently the light injected from the luminous layer outside. Thereby, when it applies to a light emitting device, it becomes possible to raise luminous efficiency.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram of the operation gestalt of this invention.
[Drawing 2] It is the manufacture flow chart of the semiconductor device shown in drawing 1 .
[Drawing 3] It is the block diagram of equipment conventionally.
[Description of Notations]
10 Silicon on sapphire, 12 An n mold GaN layer, 14 An n mold GaN layer, 16 An InGaN luminous layer, 18 A p mold GaN layer, 20 n mold electrode, 21 A transparent electrode, 22p mold electrodes.

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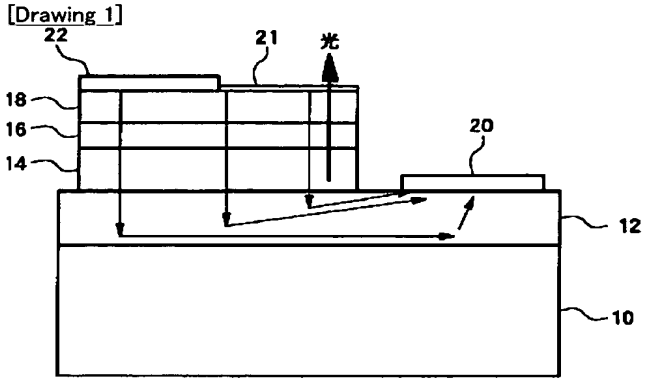
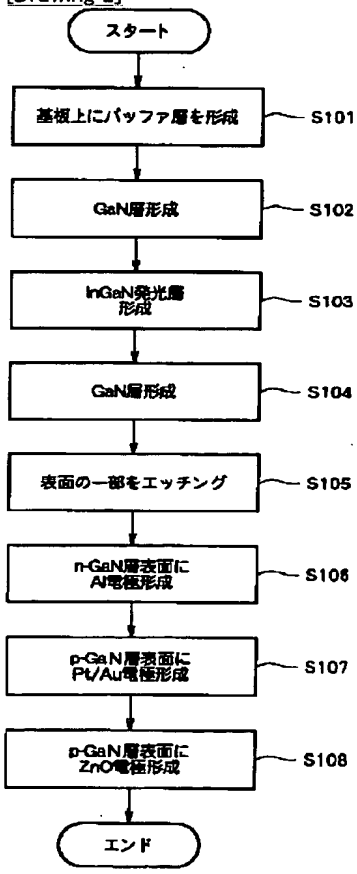
DRAWINGS

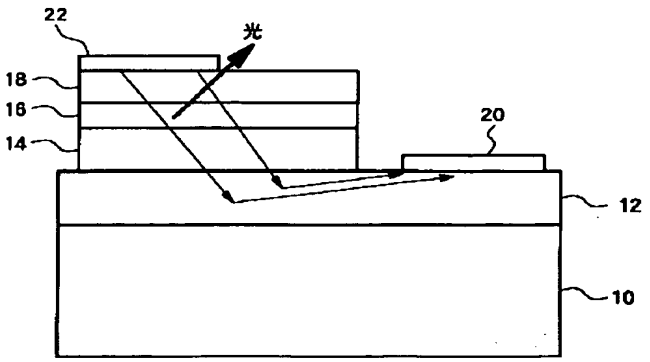
[Drawing 1]



[Drawing 2]



[Drawing 3]



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